HPCBS

High Performance Commercial Building Systems

DOE2 Model Input files specifications for Package "B" HVAC Options

Element 6 – Indoor Environmental Quality

Project 2.1 – Energy Simulations and State-Wide Energy Savings

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April 18, 2001

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DOE-2 Input File for Modeling "Package B" Relocatable Classroom.

The report on the following pages, submitted to LBNL under contract by Davis Energy Group, presents the modeling inputs for DOE-2.1E simulations of the "Package B" Relocatable Classroom as defined in the HPCBS Element 6 Scope of Work. These inputs are the set that will be used in preliminary modeling runs prior to field data collection conducted as part of Element 6 Project 2.2. It is possible that these inputs may be altered as the modeling effort proceeds and routines are refined. Revised model input files will be supplied to CEC if and when such alterations occur.

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HPCBS Element 6, Project 2.1: Relocatable Classroom Preliminary DOE2 Input File

Report Issued: April 16, 2001

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Building Description

The relocatable classroom (RC) used in the element 6 study is a standard 24' x 40' modular classroom consisting of two 12' x 40' rigid steel frame modules connected together along the long axis (see Figure 1). Each classroom has one 4' x 8' window on each end and a 6'8" x 3' door at one end. The walls are framed in wood on 16" centers and covered with T-111 plywood siding on the outside and architectural fabric covered gypsum board on the inside. The roof consists of a single slope of standing-seam roofing on metal purlins with a dropped T-bar ceiling at 8'6" (see Figure 2). The floor is carpeted on plywood set over metal purlins. Lighting consists of 12 recessed fluorescent troffers set in the ceiling and a single fluorescent vapor-jar outside the door. The base case HVAC system consists of a wall-mounted heat pump with flex-duct connected to three supply registers in the ceiling and a through-the-wall return. The HPCBS cooling system consists of a wall-mounted indirect-direct evaporative cooler (IDEC) with flex-duct connected to three supply registers in the ceiling and three through-the-wall gravity relief dampers. Heating is provided by a hydronic-heating coil in the supply plenum and connected to a wall-mounted instantaneous gas water heater.

Figure 1: RC Plan View

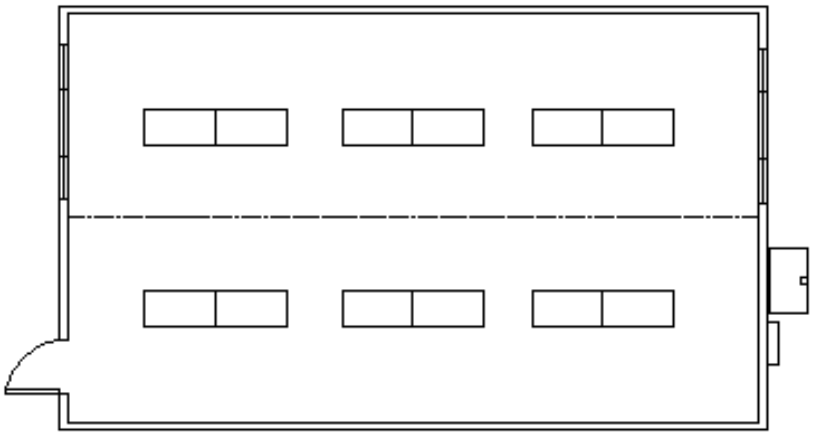
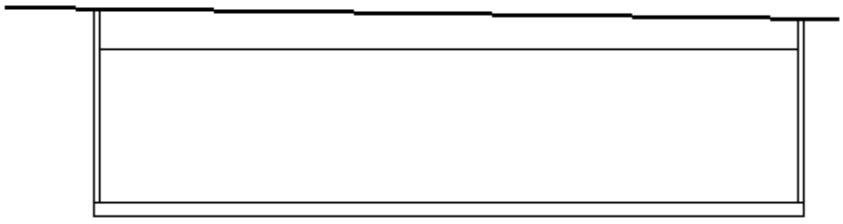


Figure 2: RC Section



DOE2 Input File

The RC was modeled using DOE-2.1E release 130. Structural inputs were taken from working drawings provided by the manufacturer. Performance and operating inputs were developed using a combination of manufacturer's data, monitored data obtained during previous PG&E RC projects (DEG, 2000), and engineering judgement. A listing of the input file is provided in the Appendix.

Loads

As would be expected for such a simple building, the loads input section is very simple and a graphical view of it is shown in Figure 3. All surfaces except the door are modeled with custom weighting factors. Table 1 summarizes some of the loads inputs that stay constant during all runs and Figure 4 shows the assumed occupancy and lighting profiles.

Figure 3: Graphical View of the DOE2 Loads Input

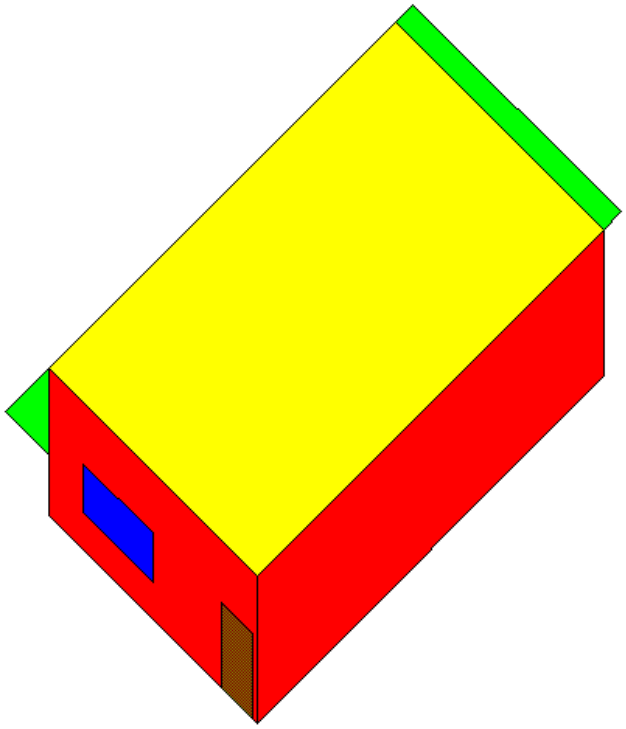
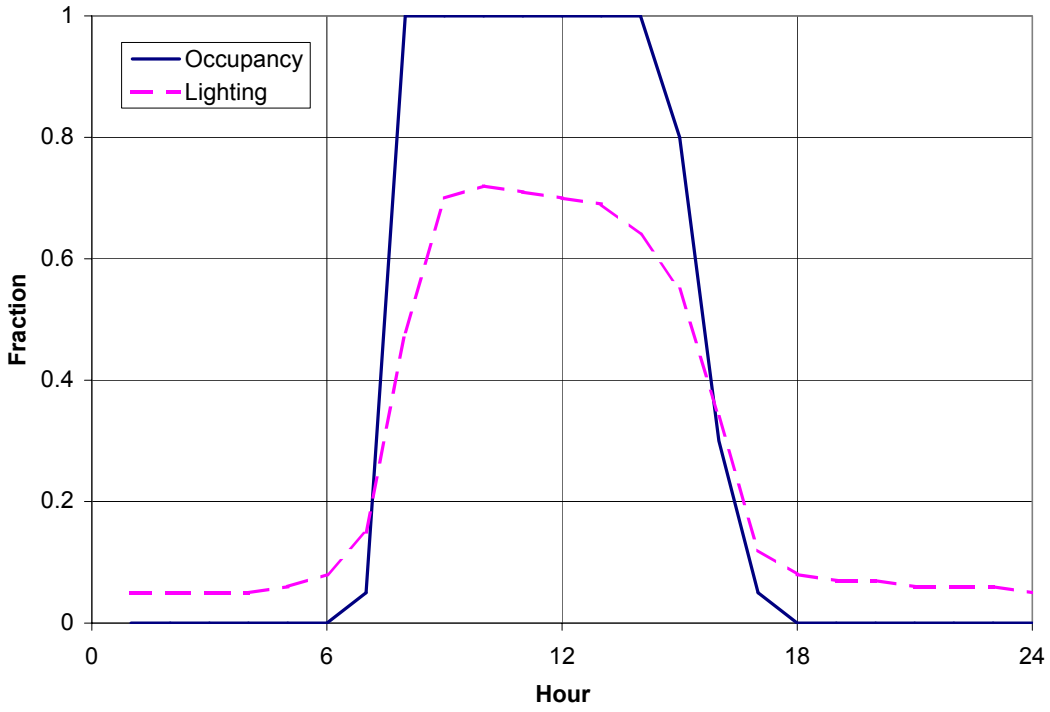


Table 1: DOE2 Loads Inputs

Input	*Value*
PEOPLE-HG-LAT	120
PEOPLE-HG-SENS	180
NUMBER-OF-PEOPLE	21
Roof R-value	19

Figure 4: DOE2 Loads Profiles



Inputs for the base case and HPCBS classrooms are compared in Table 2. The base case uses the standard insulation and equipment found in the manufacturers usual classroom specification, while the HPCBS classroom uses the PG&E Portable Efficient Relocatable Classroom (PERC) package one specifications plus a white-coated roof.

Table 2: Comparison of Base Case and PERC Inputs

Input	*Base Case*	*HPCBS*
Wall R-value	11	13
Floor R-value	11	19
GLASS-TYPE-CODE	2212 (gray tint)	2660 (selective surface)
Roof ABSORPTANCE	0.60 (bare metal)	0.25 (white coating)
Roof OUTSIDE-EMISS	0.50	0.95
LIGHTING-KW	1.66	0.75

Systems

System operating assumptions have the largest effect on annual energy consumption of any DOE2 inputs and yet are the least well defined. A wall-mounted thermostat controls relocatable classroom HVAC equipment. This control may have some communication with a central EMCS but is typically set at the discretion of the teacher or custodian. Equipment may or may not be turned off during nights and weekends and setbacks may or may not be implemented.

Operating schedules and set points were developed using monitored data from six relocatable classrooms. Fans are assumed to operate weekdays from 8am to 4pm with night operation set to CYCLE-ON-ANY and an outside airflow of 315 cfm (15 cfm/person). The heating set point is 70°F from 8am to 4pm with a set back to 65°F at night and 60°F on the weekends. The cooling set point is 76°F on weekdays and 85°F on weekends. Yearly operation can be set to be 9-month (September-June) or all-year.

The inputs used for the base case 10 SEER wall-mount heat pump are summarized in Table 3. Custom efficiency, capacity, and PLR curves are based on manufactures detailed data.

Table 3: Base Case System Inputs

Input	*Value*
SYSTEM-TYPE	PSZ
HEAT-SOURCE	HEAT-PUMP
SUPPLY-FLOW	1400
FAN-CONTROL	CYCLING
SUPPLY-KW/FLOW	0.00032
INDOOR-FAN-MODE	INTERMITTENT
COOLING-CAPACITY	42000
COOLING-EIR	0.349
COOL-SH-CAP	33600
HEATING-EIR	0.4619

Inputs for the HPCBS system are summarized in Table 4. The DOE2 stand-alone evaporative cooler model is used with the default effectiveness curves until detailed data is available on the performance of the installed IDEC. Fan power, which is critical to the performance of the IDEC system, is currently controlled using the DOE2 default SPEED curve but a function to accurately calculate the fan power is still being debugged. The instantaneous water heater is modeled as a plant boiler with an HIR of 1.18 (85% efficiency) and no standby or jacket losses.

Table 4: HPCBS System Inputs

Input	*Value*
SYSTEM-TYPE	EVAP-COOL
EVAP-CL-TYPE	INDIRECT-DIRECT
DIRECT-EFF	0.90
INDIR-EFF	0.50
EVAP-CL-KW	0.00005
EVAP-CL+REC-RA	NO
HEATING-CAPACITY	-35000
HEAT-SOURCE	HOT-WATER
SUPPLY-CFM	1600
SUPPLY-KW/FLOW	0.0006
FAN-CONTROL	SPEED
INDOOR-FAN-MODE	CONTINUOUS

References

DEG (2000) *Premium Efficiency Relocatable Classroom Performance Assessment in PG&E Territory*, , PG&E Internal Report from Davis Energy Group dated 12/29/2000, PG&E Project Manager Larry Stevens, Pacific Gas and Electric Company, San Francisco, CA.

Appendix A
DOE2 Input File Listing

```
INPUT LOADS ..

$*********************************************************
$       High Performance Building Systems Task 6
$           24x40 Modular Classroom Building
$         Author: Leo Rainer, Davis Energy Group
$                        2/14/01
$*********************************************************

$ -----------------------------------------------------------
$              Macros
$ -----------------------------------------------------------
##include Z:/ANALYSIS/HPBS/DOE2/input.inc

##if #[run[] eqs "base"]  $ base case conditions
   ##set1 fankw  0.00032
   ##set1 ceir   0.349
        ##set1 heir      0.4619
        ##set1 light  1.66
        ##set1 glass  "2212"     $ grey tint
        ##set1 wallr  "IN11"
        ##set1 floorr "IN11"
        ##set1 leak   0.0005
        ##set1 absorp 0.6               $ bare standing seam
        ##set1 emiss  0.5
##elseif #[run[] eqs "pkg1"]  $ PERC package 1 envelope + white roof
   $##set1 fankw  0.00019
   $##set1 ceir          0.28
        $##set1 heir     0.37
   ##set1 fankw  0.00032
   ##set1 ceir   0.349
        ##set1 heir      0.4619
        ##set1 light  0.750
        ##set1 glass  "2660"     $ selective surface
        ##set1 wallr  "IN13"     $ R13 wall
        ##set1 floorr "IN12"     $ R19 floor
        ##set1 leak   0.0005
        ##set1 absorp 0.25       $ white roof
        ##set1 emiss  0.95
##elseif #[run[] eqs "idec"] $ HPBS idec spec
        ##set1 light  0.750
        ##set1 glass  "2660"           $ selective surface
        ##set1 wallr  "IN13"       $ R13 wall
        ##set1 floorr "IN12"       $ R19 floor
        ##set1 leak   0
        ##set1 absorp 0.25             $ white roof
        ##set1 emiss  0.95
##endif

##if #[fan[] eqs "cycle"]         $ cycling indoor fan
   ##set1 mode  INTERMITTENT
   ##set1 sched "FAN-OFF"
        ##set1 econo   FIXED
##elseif #[fan[] eqs "on"]        $ indoor fan always on
   ##set1 mode  CONTINUOUS
   ##set1 sched "FAN-ON"
        ##set1 econo   FIXED
##elseif #[fan[] eqs "econo"]  $ economizer
   ##set1 mode  CONTINUOUS
   ##set1 sched "FAN-ON"
        ##set1 econo   TEMP
##endif

##set1 people  21                $ occupants
##set1 osa     315            $ outside air
```

```
$ ---------------------------------------------------------
$              Title, Run Periods, Design Days, Holidays
$ ---------------------------------------------------------

TITLE
   LINE-1           = *HPBS 24x40 Modular Classroom*
   LINE-2           = *System*
   LINE-3           = *Climate Zone*
   LINE-4           = *Options*
   ..

ABORT ERRORS  ..
LIST WARNINGS NO-LIMITS              ..
RUN-PERIOD JAN 1 2000 THRU DEC 31 2000      ..
BUILDING-LOCATION
   AZIMUTH   = 270           $  direction front door is facing (W = worst case)
        ..
          LOADS-REPORT
$          VERIFICATION (LV-A,LV-B,LV-C,LV-D,LV-E,LV-F,LV-G,LV-H,LV-I,LV-J,LV-K)
           VERIFICATION (LV-D,LV-F)
           SUMMARY=(LS-E,LS-F)
           HOURLY-DATA-SAVE=FORMATTED ..


$ ---------------------------------------------------------
$              Materials / Layers / Constructions
$ ---------------------------------------------------------


WALLAY = LAYERS
   MATERIAL         = ( PW03, wallr[], GP02)
   INSIDE-FILM-RES=.68
   ..
ROOFLAY = LAYERS
   MATERIAL         = ( AS01, IN03, AL33, AC02)
   INSIDE-FILM-RES=.765
   ..
FLOORLAY = LAYERS
   MATERIAL         = ( floorr[], PW05, CP02)
   INSIDE-FILM-RES=.765
   ..

WALLCON = CONSTRUCTION
   ABSORPTANCE      = 0.50
   LAYERS           = WALLAY
   ..
ROOFCON = CONSTRUCTION
   ABSORPTANCE      = absorp[]
   LAYERS           = ROOFLAY
   ..
FLOORCON = CONSTRUCTION
   LAYERS           = FLOORLAY
   ..
DOORCON  = CONSTRUCTION  $ solid ureth. door wo/T-B
      U-VALUE=.40 ..

$ ---------------------------------------------------------
$              Glass Types
$ ---------------------------------------------------------

WINDOWCON = GLASS-TYPE
   GLASS-TYPE-CODE  = glass[]
   $FRAME-CONDUCTANCE = FRAMECON
  ..


$ ---------------------------------------------------------
$              Day Schedules
$ ---------------------------------------------------------

OCC-WD = DAY-SCHEDULE
```

```
           HOURS = (1,7)     VALUES = (0)
           HOURS = (8)       VALUES = (.05)
           HOURS = (9,14)    VALUES = (1)
           HOURS = (15)      VALUES = (.8)
           HOURS = (16)      VALUES = (.30)
           HOURS = (17)      VALUES = (.05)
           HOURS = (18,24)   VALUES = (0)
   ..
OCC-WE = DAY-SCHEDULE
   (1,24) ( 0 )
   ..
LIGHT-WD = DAY-SCHEDULE
   (1,24) ( 0.05,0.05,0.05,0.05,0.06,0.08,0.15,0.48,0.70,0.72,0.71,
               0.70,0.69,0.64,0.55,0.34,0.12,0.08,0.07,0.07,0.06,0.06,0.06,0.05)
   ..
LIGHT-WE = DAY-SCHEDULE
   (1,24) ( 0.05 )
   ..

$ ---------------------------------------------------------
$              Week Schedules
$ ---------------------------------------------------------

OCC-WEEK = WEEK-SCHEDULE
            DAYS    (WD)         DAY-SCHEDULE = OCC-WD
            DAYS    (WEH)        DAY-SCHEDULE = OCC-WE
   ..
LIGHT-WEEK = WEEK-SCHEDULE
            DAYS    (WD)         DAY-SCHEDULE = LIGHT-WD
            DAYS    (WEH)        DAY-SCHEDULE = LIGHT-WE
   ..

$ ---------------------------------------------------------
$              Annual Schedules
$ ---------------------------------------------------------

LIGHTING = SCHEDULE
           THRU DEC 31          WEEK-SCHEDULE = LIGHT-WEEK
   ..
OCC = SCHEDULE
           THRU DEC 31          WEEK-SCHEDULE = OCC-WEEK
   ..


$ *********************************************************
$ **                                                     **
$ **      Floors / Spaces / Walls / Windows / Doors      **
$ **                                                     **
$ *********************************************************


CLASSRM = SPACE
       AREA             = 960
   VOLUME           = 11520
   TEMPERATURE      = (74)
   PEOPLE-SCHEDULE  = OCC
   LIGHTING-SCHEDUL = LIGHTING
   LIGHTING-TYPE    = REC-FLUOR-NV
   PEOPLE-HG-LAT    = 120
   PEOPLE-HG-SENS   = 180
   LIGHTING-KW      = light[]
   NUMBER-OF-PEOPLE = people[]
   $PEOPLE-HEAT-GAIN = 350
   DAYLIGHTING      = NO
   INF-METHOD       = S-G
   HOR-LEAK-FRAC    = 0.3
   FRAC-LEAK-AREA   = leak[]
   FLOOR-WEIGHT     = 0
   ..

FRONTSH = BUILDING-SHADE
```

```
   HEIGHT           = 5
        WIDTH            = 24
        X                = 0
        Y                = 0
        Z                = 12
        TILT             = 180
        AZIMUTH          = 180
        ..
BACKSH = BUILDING-SHADE
   HEIGHT           = 2
        WIDTH            = 24
        X                = 24
        Y                = 40
        Z                = 12
        TILT             = 180
        AZIMUTH          = 0
        ..
FRONTW = EXTERIOR-WALL
   CONSTRUCTION     = WALLCON
        HEIGHT           = 12
   WIDTH            = 24
        X                = 0
        Y                = 0
        AZIMUTH          = 180
   ..
FWINDOW = WINDOW
   GLASS-TYPE       = WINDOWCON
   X                = 4
   Y                = 3
   HEIGHT           = 4
   WIDTH            = 8
   ..
FDOOR = DOOR
   CONSTRUCTION     = DOORCON
   X                = 20
   HEIGHT           = 7
   WIDTH            = 3.5
   ..

BACKW = EXTERIOR-WALL
   LIKE FRONTW
        X                = 24
        Y                = 40
        AZIMUTH          = 0
   ..
BWINDOW = WINDOW
   GLASS-TYPE       = WINDOWCON
   X                = 4
   Y                = 3
   HEIGHT           = 4
   WIDTH            = 8
   ..

RIGHTW = EXTERIOR-WALL
   CONSTRUCTION     = WALLCON
        HEIGHT           = 12
   WIDTH            = 40
        X                = 24
        Y                = 0
        AZIMUTH          = 90
   ..

LEFTW = EXTERIOR-WALL
   LIKE RIGHTW
        X                = 0
        Y                = 40
        AZIMUTH          = 270
   ..

ROOF-1 = ROOF
   CONSTRUCTION     = ROOFCON
```

```
   HEIGHT           = 40
   WIDTH            = 24
        X               = 0
        Y               = 0
        Z               = 12
        AZIMUTH         = 180
        TILT            = 0
        OUTSIDE-EMISS   = emiss[]
   ..

FLOOR-1 = EXTERIOR-WALL
   CONSTRUCTION     = FLOORCON
   HEIGHT           = 40
   WIDTH            = 24
        X               = 0
   Y                = 40
        Z               = 0
        AZIMUTH         = 180
        TILT            = 180
   ..

END ..

COMPUTE LOADS ..

INPUT SYSTEMS ..
     SYSTEMS-REPORT
          HOURLY-DATA-SAVE=FORMATTED
     VERIFICATION (SV-A)
     SUMMARY=(SS-A,SS-F,SS-H)
          ..


##ifdef func[]
     SUBR-FUNCTIONS
          VARVOL-0=*SETSPEED*
          VARVOL-1Z=*ADDLOAD*
          VARVOL-2=*SAVETEMP*
          VARVOL-3=*SAVELOAD*
          ..
##endif

$ ------------------------------------------------------------
$              Day Schedules
$ ------------------------------------------------------------

COOL-STAT-WD = DAY-SCHEDULE
   (1,24) ( 76 )
   ..
COOL-STAT-WE = DAY-SCHEDULE
   (1,24) ( 85 )
   ..
FAN-WD = DAY-SCHEDULE
           HOURS = (1,7)     VALUES = (0)
           HOURS = (8,16)    VALUES = (1)
           HOURS = (17,24)   VALUES = (0)
   ..
FAN-WE = DAY-SCHEDULE
   (1,24) ( 0 )
   ..
HEATING-STAT-WD = DAY-SCHEDULE
           HOURS = (1,7)     VALUES = (65)
           HOURS = (8,16)    VALUES = (70)
           HOURS = (17,24)   VALUES = (65)
   ..
HEATING-STAT-WE = DAY-SCHEDULE
   (1,24) ( 60 )
   ..
HEATING-STAT-SUMMER = DAY-SCHEDULE
   (1,24) ( 60 )
   ..
```

```
ALLWAYSON = DAY-SCHEDULE
   (1,24) ( 1 )
   ..

$ ---------------------------------------------------------
$              Week Schedules
$ ---------------------------------------------------------

ON-WEEK = WEEK-SCHEDULE
            DAYS    (ALL)         DAY-SCHEDULE = ALLWAYSON
        ..
FAN-OFF-WEEK = WEEK-SCHEDULE
            DAYS    (ALL)         DAY-SCHEDULE = FAN-WE
   ..
FAN-ON-WEEK = WEEK-SCHEDULE
            DAYS    (WD)          DAY-SCHEDULE = FAN-WD
            DAYS    (WEH)         DAY-SCHEDULE = FAN-WE
   ..
HEAT-WINTER-WEEK = WEEK-SCHEDULE
            DAYS    (WD)          DAY-SCHEDULE = HEATING-STAT-WD
            DAYS    (WEH)         DAY-SCHEDULE = HEATING-STAT-WE
   ..
HEAT-SUMMER-WEEK = WEEK-SCHEDULE
            DAYS    (ALL)         DAY-SCHEDULE = HEATING-STAT-SUMMER
   ..
COOL-SUMMER-WEEK = WEEK-SCHEDULE
            DAYS    (WD)          DAY-SCHEDULE = COOL-STAT-WD
            DAYS    (WEH)         DAY-SCHEDULE = COOL-STAT-WE
   ..
COOL-WINTER-WEEK = WEEK-SCHEDULE
            DAYS    (ALL)         DAY-SCHEDULE = COOL-STAT-WE
   ..

$ ---------------------------------------------------------
$              Annual Schedules
$ ---------------------------------------------------------

HEATING = SCHEDULE
           THRU MAR 31          WEEK-SCHEDULE = HEAT-WINTER-WEEK
           THRU SEP 30          WEEK-SCHEDULE = HEAT-SUMMER-WEEK
           THRU DEC 31          WEEK-SCHEDULE = HEAT-WINTER-WEEK
   ..
COOLING = SCHEDULE
           THRU MAR 31          WEEK-SCHEDULE = COOL-WINTER-WEEK
           THRU SEP 30          WEEK-SCHEDULE = COOL-SUMMER-WEEK
           THRU DEC 31          WEEK-SCHEDULE = COOL-WINTER-WEEK
   ..
FAN-ON = SCHEDULE
           THRU DEC 31          WEEK-SCHEDULE = FAN-ON-WEEK
   ..
FAN-OFF = SCHEDULE
           THRU DEC 31          WEEK-SCHEDULE = FAN-OFF-WEEK
   ..
ALLON = SCHEDULE
           THRU DEC 31          WEEK-SCHEDULE = ON-WEEK
   ..

$ *********************************************************
$ **                                                     **
$ **                Performance Curves                   **
$ **                                                     **
$ *********************************************************


##include Z:/ANALYSIS/HPBS/DOE2/curves.inc

$ *********************************************************
$ **                                                     **
$ **               HVAC Systems / Zones                  **
$ **                                                     **
$ *********************************************************
```

```
CLASSRM = ZONE
   ZONE-TYPE        = CONDITIONED
        DESIGN-HEAT-T    = 70
   DESIGN-COOL-T    = 76
   OUTSIDE-AIR-FLOW = osa[]
   HEAT-TEMP-SCH    = HEATING
   COOL-TEMP-SCH    = COOLING
   ..

##if #[run[] eqs "idec"]
SYS-1 = SYSTEM
   SYSTEM-TYPE      = EVAP-COOL
        ZONE-NAMES       =(CLASSRM)
        EVAP-CL-TYPE     = INDIRECT-DIRECT
        DIRECT-EFF       = 0.90                $ CelDek
        INDIR-EFF        = 0.50                $ Adobe HX performance for now
        EVAP-CL-KW       = .00005       $ 80W / 1600cfm pump, single fan
        EVAP-CL+REC-RA   = NO
        HEATING-CAPACITY = -35000       $ hydronic coil
   HEAT-SOURCE      = HOT-WATER
   HEATING-SCHEDULE = ALLON
   COOLING-SCHEDULE = ALLON
   SUPPLY-CFM       = 1600
        MIN-OUTSIDE-AIR  = osa[]
   FAN-SCHEDULE     = sched[]
   SUPPLY-KW/FLOW   = 0.0006    $ 1kw/1600cfm
        FAN-CONTROL      = SPEED        $ ECM
        MIN-FAN-RATIO    = 0.1
   NIGHT-CYCLE-CTRL = CYCLE-ON-ANY
   INDOOR-FAN-MODE  = mode[]
   ..
##else
SYS-1 = SYSTEM
   SYSTEM-TYPE      = PSZ
        ZONE-NAMES       =(CLASSRM)
   HEAT-SOURCE      = HEAT-PUMP
   HEATING-SCHEDULE = ALLON
   COOLING-SCHEDULE = ALLON
   SUPPLY-FLOW      = 1400
   FAN-SCHEDULE     = sched[]
   FAN-CONTROL      = CYCLING
   SUPPLY-KW/FLOW   = fankw[]
   NIGHT-CYCLE-CTRL = CYCLE-ON-ANY
   INDOOR-FAN-MODE  = mode[]
   COOLING-CAPACITY = 42000
   COOLING-EIR      = ceir[]
   COOL-SH-CAP      = 33600
   HEATING-EIR      = heir[]
        OA-CONTROL       = econo[]
        ECONO-LOCKOUT    = NO
   ..
##endif

PLANT1 = PLANT-ASSIGNMENT
   SYSTEM-NAMES = (SYS-1)
   ..

END ..

COMPUTE SYSTEMS ..

INPUT PLANT ..
PLANT1 = PLANT-ASSIGNMENT  ..

          PLANT-REPORT        SUMMARY=(BEPU,PS-B) ..

##if #[run[] eqs "idec"]
   PLANT-PARAMETERS
          HW-BOILER-HIR       = 1.18
                      E-HW-BOILER-LOSS    = 0
```

```
                        HCIRC-DESIGN-T-DROP = 20
                        HCIRC-HEAD          = 24
                        HCIRC-IMPELLER-EFF  = 0.77
                        HCIRC-LOSS          = 0
                        HCIRC-MOTOR-EFF     = 0.7
                        ..

   BOILER1         = PLANT-EQUIPMENT
         TYPE             = HW-BOILER
         INSTALLED-NUMBER = 1
         MAX-NUMBER-AVAIL = 1
         SIZE             = 0.04  ..  $ set small now to reduce plr loss (should put in
new curve)

                       PART-LOAD-RATIO
                       TYPE             = HW-BOILER
                       ELEC-INPUT-RATIO = 0.007      $ 80W/40KBTU
                       ..
##endif

END ..
COMPUTE PLANT ..
```